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Electronics Limited

Aperiodic Loop Antennas

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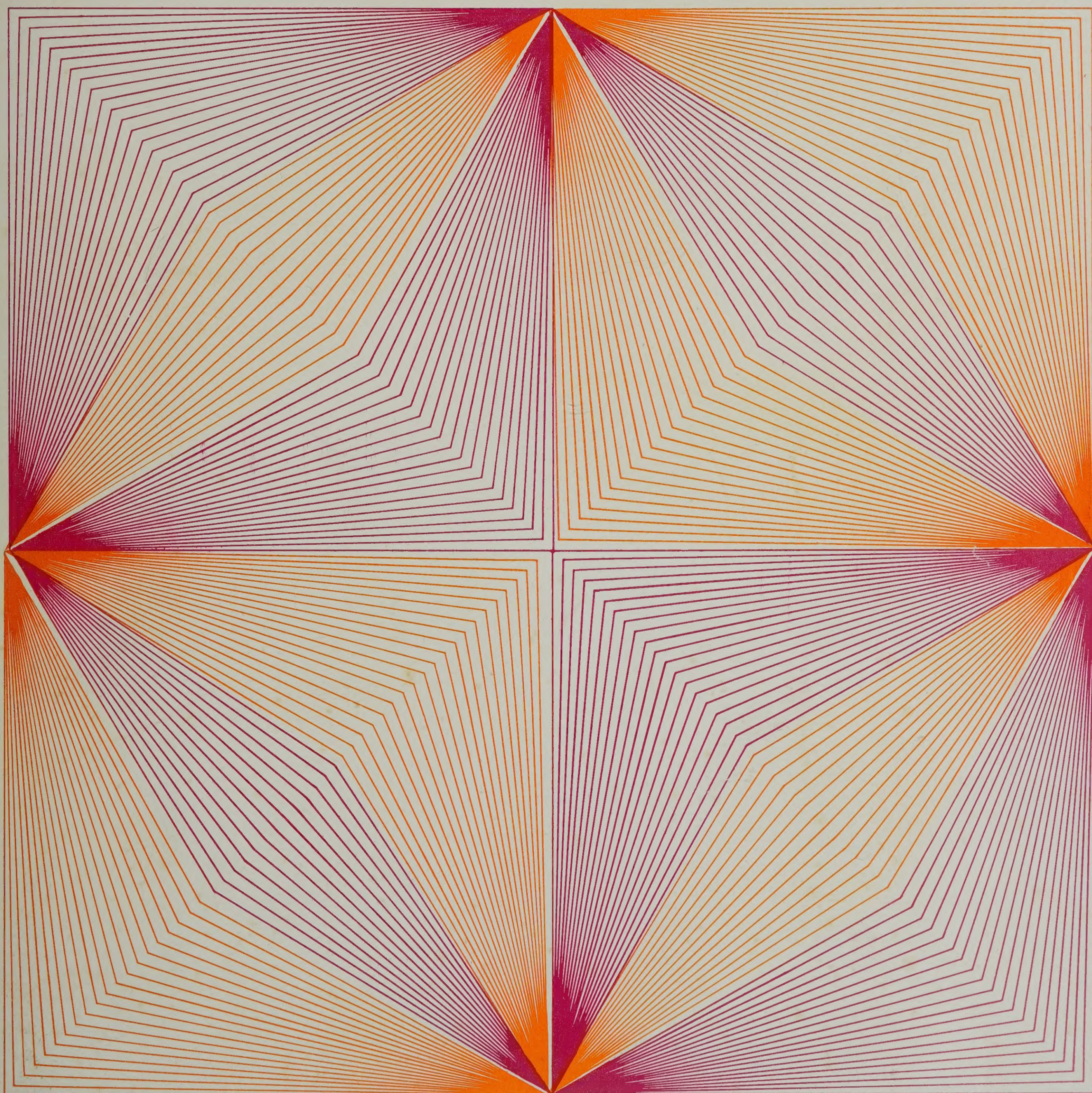
Unique broadband receiving antennas



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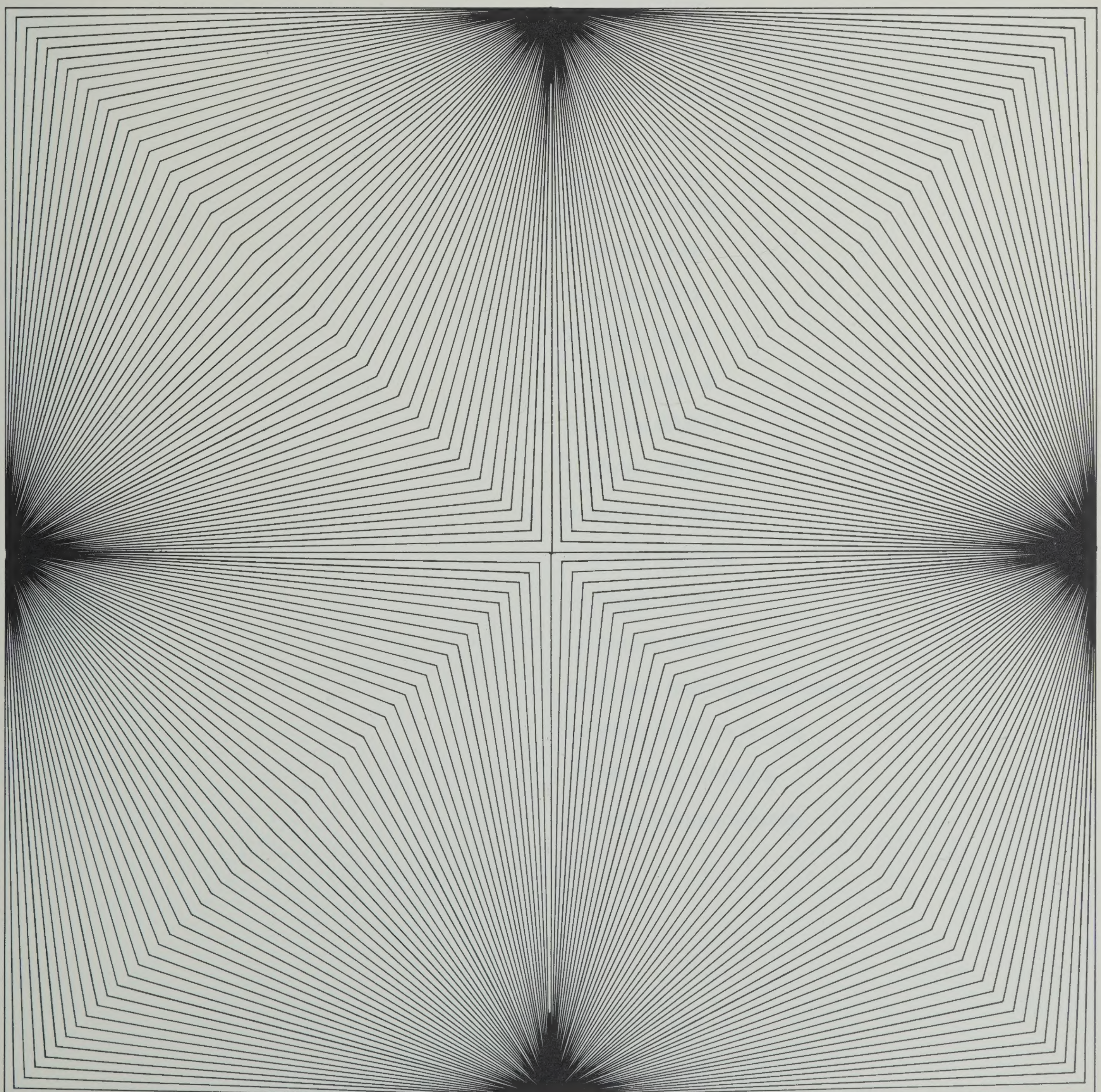
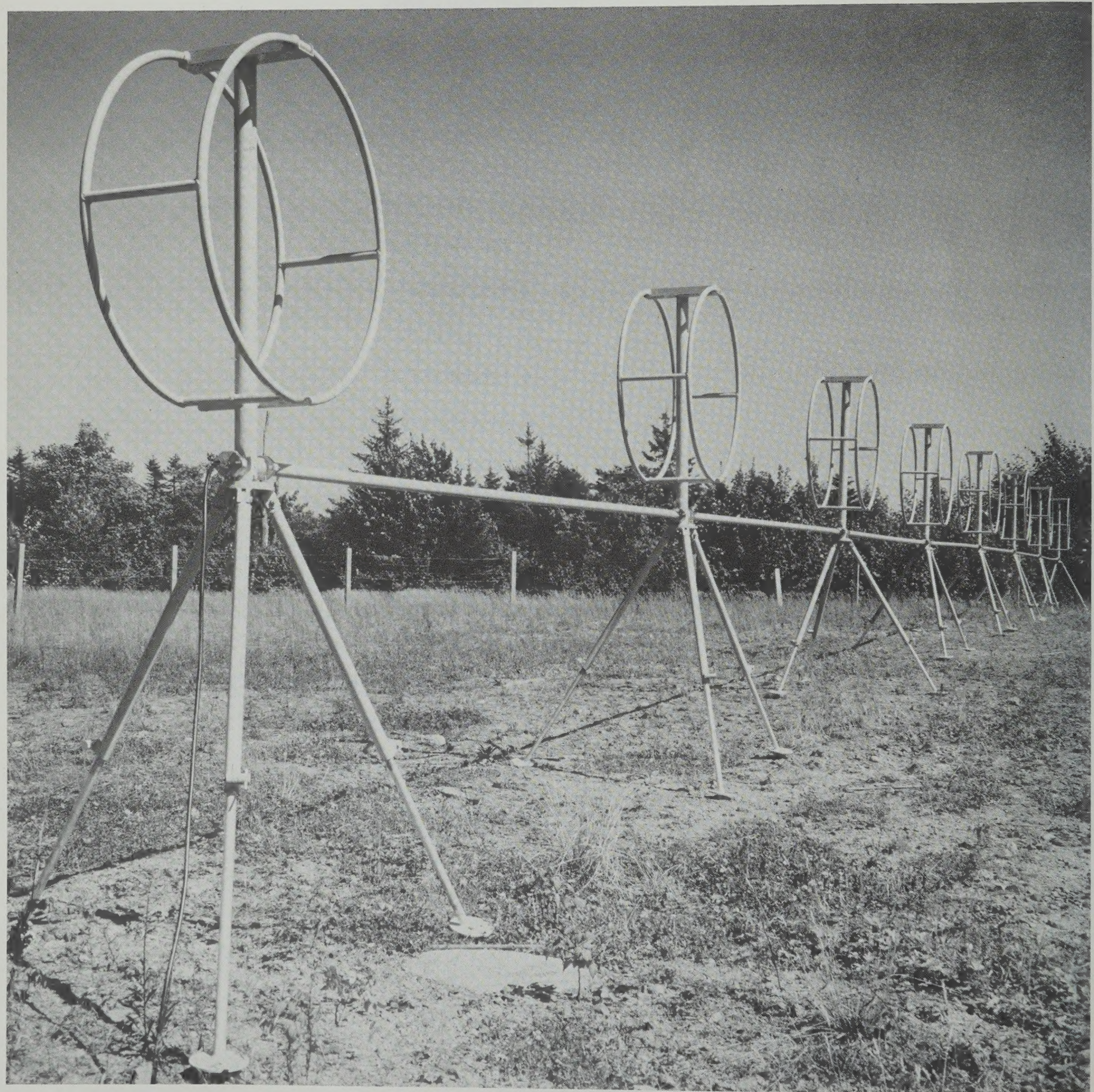


Contents

Model 8E13



Principal Users

United States Navy

United States Army

United States Air Force

United States Coastguard

Canadian Department of Transport

Atomic Weapons Research Establishment U.K.

Diplomatic Wireless Service U.K.

Government of Denmark

Government of Portugal

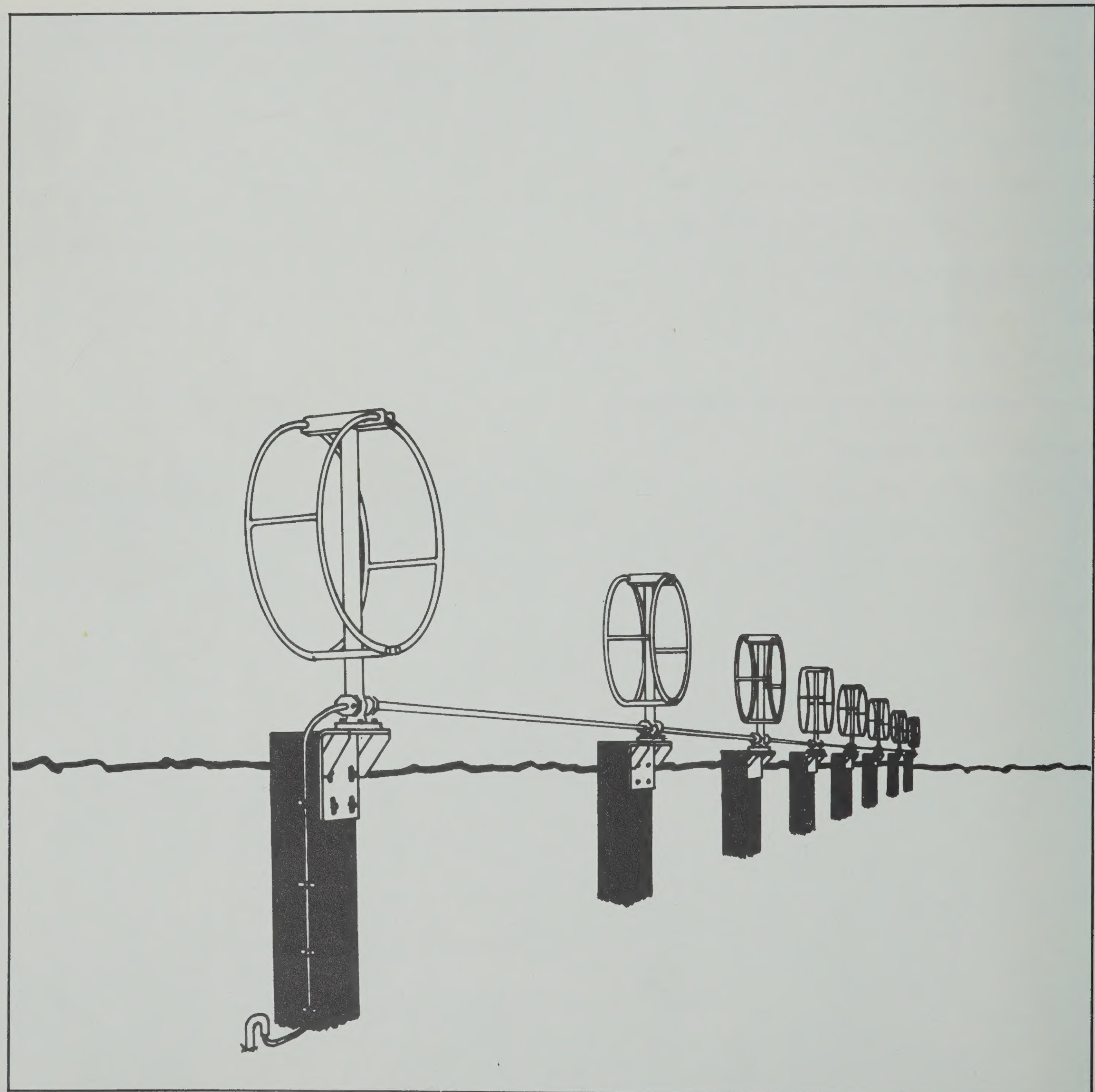
Government of the Commonwealth of Australia

German Federal Republic

Canadian Broadcasting Corporation

In addition, antennas are in service in climates varying between arctic and tropical conditions.

Model 8E13 (Post Mounted)



Aperiodic Loop Arrays

The new approach to High Frequency Receiving Antennas

The combination of an electrically small loop and a patented solid state preamplifier produces a broadband receiving antenna element covering the frequency range 2-32 MHz. The loop-preamplifier element has a performance, for reception, comparable to conventional large monopole antennas, because the incoming signal to noise ratio is limited by the high background atmospheric noise levels in the HF band.

The loop is a welded assembly of aluminum alloy tubing *only* one metre in diameter and weighing 10 pounds. It should be located close to the ground in terms of wavelength, and can be mounted on a tripod or bolted to a post with an angle bracket.

The Aperiodic Configuration comprises loop/preamplifier elements arranged along the ground, with an interconnecting transmission line, in the direction of signal arrival to form an 'end-fire' array. These linear arrays produce a unidirectional beam pattern with optimum characteristics for reception of HF signals propagated via the ionosphere. The directional gain of these arrays compares well with Log Periodic or Rhombic Antenna Systems.

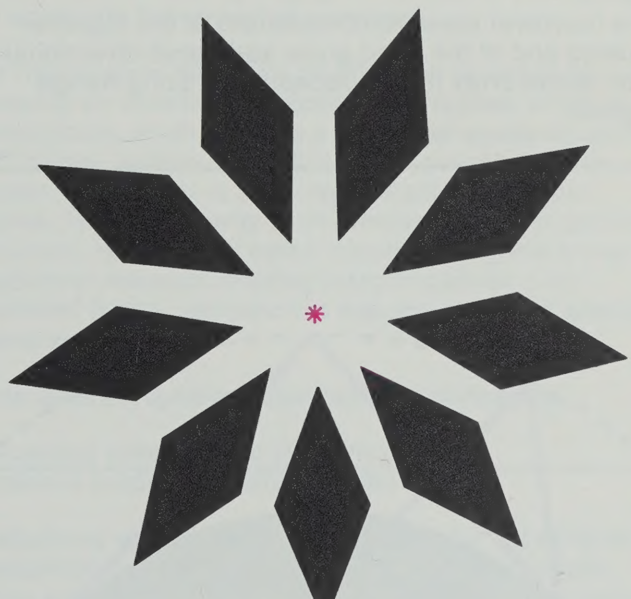
Because of the low mutual interference between the small loop elements, multiple cross array Rosette systems can be constructed, giving very efficient utilization of real estate.

What Price Real Estate?

A complete HF receive antenna capability now requires a piece of land only 50 metres in diameter.

Rosette and Circular Loop Array Systems replace vast Rhombic or Log Periodic antenna farms, and require less than one *hundredth* of the land area.

These antenna systems provide, over the frequency range 2-32 MHz, a number of high gain overlapping beams, all available simultaneously, covering all possible azimuth directions.

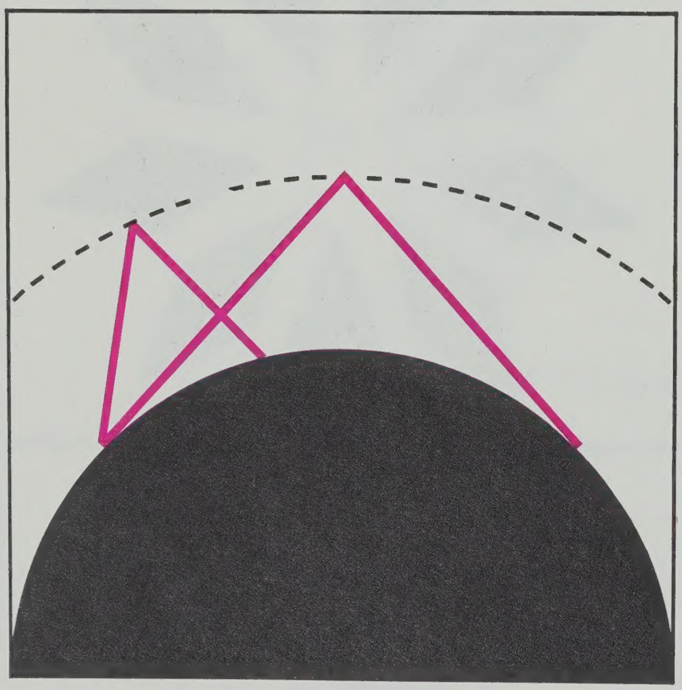


At Last One Antenna For Both Long and Short Haul Communication

The loop antenna element receives signals equally from all elevation arrival angles.

Short range communication via the ionosphere depends on acute reflection angles, and is only possible at the lower frequency end of the HF band. Aperiodic Loop Arrays have a wide elevation beamwidth at the lower frequency end of the HF band allowing short range signals to be received with substantial antenna gain.

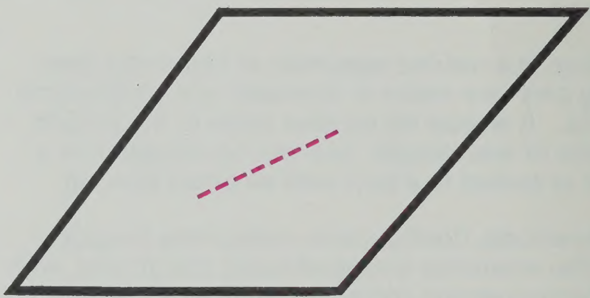
The narrower elevation beamwidth at the high frequency end of the band gives additional directional gain to the array for the reception of Long Range signals.



Add Diversity Reception Without Adding Real Estate

Aperiodic Loop Arrays can be located on the ground, directly underneath your existing horizontally polarized antenna, to provide polarization diversity reception.

The small size of the arrays enables them to be easily installed, without requiring any additional real estate.



The New Low Profile HF Antenna

Aperiodic Loop Arrays are small enough to mount on a roof or conceal just below ground level.

They can be erected or taken down by an unskilled team, without special equipment, in less than one hour.

An 8 loop *Ultra Compact* array packs into two cases 4' x 2½' x 1½', and weighs less than 150 pounds.

General Description

Introduction

The basic antenna element is an *untuned balanced loop* whose dimensions are small compared with the wavelength. A patented preamplifier circuit fitted at the base of the antenna exactly complements the loop characteristics. This combination results in a constant effective height over the frequency range 2-32 MHz, that is, the preamplifier output voltage is constant over the complete frequency range for a fixed incident field strength. Because of the flat frequency response the antenna has well defined phase characteristics and is, therefore, particularly suited for a phased antenna system.

The aperiodic configuration comprises loop/preamplifier elements in an 'end fire' array with an interconnecting transmission line coupling each element. The element spacing has been carefully chosen to provide optimum directional characteristics for both long and short haul, point-to-point h. f. communication via the ionosphere. Outputs are available at both ends so that the array can look both ways simultaneously, if required, or can be rapidly switched through 180 degrees with a coaxial relay.

Design Philosophy

At frequencies above about 100 MHz the problems of receiving and transmitting antenna design are interchangeable except, perhaps, that the radiating element operates with a voltage stress. Below 100 MHz, and to a much greater extent below 30 MHz, this is no longer true because of the effects of atmospheric and galactic noise sources. Whilst a requirement for free-space coupling efficiency remains for the transmitting antenna, it does not for the receiving antenna. For example, at VLF a large copper curtain is necessary for the transmitting array but a small whip antenna having negligible free space coupling, is adequate for receiving purposes.

At frequencies less than 30 MHz it is possible to employ an antenna for receiving purposes which is electrically small and has a poor free-space coupling efficiency, without prejudicing the overall system noise factor. This is because the antenna output noise comes primarily from atmospheric and galactic sources, the thermal noise introduced by the antenna radiation resistance being insignificant by comparison, if this resistance is assumed to be at ambient temperature.

The antenna system noise factor is defined as

$$\frac{\text{incoming atmospheric signal/noise ratio}}{\text{antenna output signal/noise ratio}}$$

Tabulated values of this noise factor for six different geographic locations are given below for a *single loop antenna element.* The atmospheric background noise values for these calculations were taken from the contours given in CCIR Report No. 322 (Atmospheric Radio Noise Data) averaged over all four seasons of the year. The two lower frequencies (2 and 4 MHz) were computed on the basis of nighttime interference levels only since long haul communication using these frequencies is normally practicable only at this time. For similar reasons, the two higher frequencies (16 and 32 MHz) were computed for daytime periods only. The 8 MHz frequency was taken over the complete 24 hour period.

Antenna System Noise Factor (Single Loop)

Location	Frequencies 2 MHz	4 MHz	8 MHz	16 MHz	32 MHz
United Kingdom	2.5 dB	<1.0 dB	2.3 dB	3.5 dB	5.0 dB
North America	<1.0 dB	<1.0 dB	<1.0 dB	3.5 dB	5.0 dB
South America	<1.0 dB	<1.0 dB	<1.0 dB	3.2 dB	5.0 dB
Hawaii	1.5 dB	<1.0 dB	2.3 dB	3.5 dB	5.0 dB
South East Asia	<1.0 dB	<1.0 dB	<1.0 dB	3.2 dB	5.0 dB
Africa	<1.0 dB	<1.0 dB	<1.0 dB	3.0 dB	5.0 dB

It is clear that the small size of the antenna does not prejudice its performance to any practical extent in most world locations.

With 'N' loop antennas arranged as an array the signal amplitude is increased 'N' times, but the preamplifier noise only increases by $\sqrt{N}$ giving a further improvement in signal to noise ratio.

Directional Characteristics

The Specification sheets following show the directional characteristics of various loop arrays, the elevation pattern being shown as a broken line and the azimuth in full line.

These show that Aperiodic Loop Antenna Arrays provide ideal directional characteristics for both long and short haul communications using ionospheric reflection. Long distance reception at higher frequencies in the 2-32 MHz band benefits from the narrow beamwidth and corresponding higher antenna gain.

Short haul communication which depends upon acute reflection angles, is generally only possible at the lower part of the frequency range because of the nature of the reflecting characteristics of the ionized layers; the wider elevation beamwidth of the antenna at these frequencies allows signals arriving at near vertical incidence to be received with substantial antenna gain.

Operation in the Presence of Strong Unwanted Signals

Each preamplifier is designed to handle a peak signal strength of more than 2 V/m without overloading. In the h. f. band this is greater than the signal from a 10 kW transmitter at a distance of one mile over land.

Filters are included in the standard preamplifier to suppress signals below 2 MHz and above 32 MHz. This reduces interference from high level local broadcast and TV signals. Special notch filters can be designed to reject unusually strong individual signals present at a particular site, but these must be specified at the time of ordering. For example: a system has been designed to operate 1/3 mile from a 10 kW 600 kHz broadcast transmitter.

Aperiodic antenna arrays yield second order intermodulation products down more than 70 dB, and third order 100 dB below two signals of 10 mV/m. For example, the 8 loop array, model 8E13, has an effective height of 8 metres and the intermodulation products would be 70 and 100 dB down on two multicoupler output signals of 80 mV. This is equivalent to 60 dB (second order) and 80 dB (third order) down relative to two 0.25 volt output signals. This performance compares well with active multi-couplers found at most receiving sites.

Power Supply and Multi-Coupler

D. C. power is fed to the loop preamplifiers via the coaxial cable connecting the array to the receiver building and no additional cables are necessary. The rack-mounted power supply unit located in the receiver building includes a multi-coupler enabling four receivers to be operated independently and simultaneously from a single array. Further multi-coupler outputs can be provided to customer requirement.

The power supply output circuit is current limited to prevent damage due to short circuit conditions and includes an ammeter showing the total current drawn by the array amplifiers. This provides an indication of a fault condition in a preamplifier.

Reliability

The preamplifiers are conservatively designed to operate over the full external environmental temperature range of $-40°C$ to $+70°C$. They are contained in a sealed unit which plugs into the central tube of the loop from below, providing double protection from the weather.

Each preamplifier contains a fuse so that if a short-circuit develops it will disconnect itself from the transmission line. Even if a preamplifier ceases to function the array will still operate with little reduction in performance.

The calculated MTBF of an individual preamplifier at $+70°C$ ambient is ¼ of a million hours, i.e., just under 30 years.

Maintenance

Since the preamplifiers are located outside, remote from the receiving building, careful thought has been given to ease of maintenance. The preamplifiers plug into the central tube at the base of the loop and are secured by only four screws. Test points on each preamplifier are accessible through the base of the central tube without removing the unit. A faulty preamplifier can thus be quickly located and changed.

Mechanical Design of Loop Element

The loops should be located close to the ground in terms of wavelength so that the direct and reflected signals add in phase. To allow for build-up of snow or ground water, they are mounted on tripods about three feet above the ground and are adjustable to accommodate a variation of up to two feet in site irregularities. An alternative method of mounting is to bolt the loops onto posts with an angle bracket.

Each loop is supported by a tube in which the preamplifier is located. This tube effectively grounds the centre of the loop to obviate electrostatic pickup and minimize damage due to lightning strike. The loop element is a welded assembly of aluminum alloy tubing weighing only 10 lbs., and is stressed to withstand a wind speed of 200 miles per hour.

Other Applications

Because of the low mutual interference between the untuned loop/preamplifier elements, multiple cross array systems can be constructed. For example, four 8-loop arrays arranged radially through a common centre point provide omnidirectional coverage without mutual interference (Model 4R/8E13). Both ends of each array can be fed to the receiving building and all 8 outputs used simultaneously. Wide azimuth coverage arrays can be made by combining the outputs of crossed arrays.

By placing loop antennas around the circumference of a circle and connecting them to central phasing networks, all the loops can contribute to the gain in

a given direction. Model 18C50 is such a system. It produces 36 high gain beams centered on azimuth bearings 10 degrees apart. This array is the equivalent of 18 Rhombic antennas and occupies less real estate than one of them.

An ultra compact version of the loop elements is available in which the transmission line and the legs are arranged to pack within the folded half loop sections, for mobile tactical applications.

An interferometer array is a practical proposition with these loop/preamplifier elements since the phase characteristics are clearly defined.

The technique is equally suitable for lower frequency applications, offering the possibility of directional receiving antenna arrays for the MF, LF and even VLF bands.

Hermes engineers will be pleased to discuss special antenna requirements such as roof-top or underground locations.

Antenna Selection Chart

Model	Directional gain dB (rel. to Isotropic) 2	5	10	15	20	30 MHz	Beamwidth between 3dB pts. Azimuth 5 MHz	Azimuth 30 MHz	Elevation 5 MHz	Elevation 30 MHz	Site Requirements Length metres	Width metres	Approx. Relative Cost	Comments
Linear Arrays														
4E26	5	8	10	11	9	11	86°	54°	80°	30°	25	1	0.8	Long, Med and Short Haul Circuits
8E13	5	8	10	12	13	14	86°	54°	80°	30°	30	1	1.0	Long, Med and Short Haul Circuits
8E26	8	10	13	14	11	14	76°	40°	54°	21°	60	1	1.4	Long and Med Haul Circuits
16E13	8	10	13	14	15	17	76°	40°	54°	21°	60	1	1.9	Long and Med Haul Circuits
2B/8E13	6	10	13	15	16	17	66°	16°	80°	30°	30	20	1.9	Long, Med and Short Haul Circuits
2B/8E26	8	11	15	16	14	17	66°	16°	54°	21°	60	20	2.6	Long and Med Haul Circuits
2B/16E13	8	11	15	17	18	20	66°	16°	54°	21°	60	20	3.7	Long and Med Haul Circuits
Rosette Systems														
3R/4E26	5	8	10	11	9	11	86°	54°	80°	30°	25 m diameter		2.6	Omnidirectional coverage in Azimuth in 6 sectors
4R/8E13	5	8	10	12	13	14	86°	54°	80°	30°	30 m diameter		4.0	Omnidirectional coverage in Azimuth in 8 sectors
18C50	8	12	14	16	16	17	40°	9°	60°	22°	50 m diameter		6.5	Omnidirectional coverage in Azimuth in 36 sectors

1. Linear Arrays

First *numbers* indicate number of elements in array.
Next *letter* indicates type of array, i.e., 'E' endfire.
Next *numbers* indicate inter element spacing in feet.

2. Combination of Linear Arrays

First *number* indicates number of arrays.
Next *letter* indicates arrangement of arrays i.e., B for Broadside, R for Rosette.
Finally the model number for individual linear arrays.

3. Circular Arrays

First *numbers* indicate number of elements in array.
Next *letter* indicates type of array i.e., 'C' for Circular.
Next *numbers* indicate diameter in metres.

Single Loop Element

The loop element is an untuned balanced loop whose dimensions are small compared to the wavelength for frequencies up to 32 MHz. A patented preamplifier fitted at the base of the antenna exactly complements the loop characteristics, resulting in an antenna element with a constant effective height over the frequency range 2-32 MHz. This means that the preamplifier output voltage is constant over the working frequency range for a fixed incident field strength. The broadband response of the loop-preamplifier combination results in well defined phase characteristics, and hence makes the element very suitable for use in phased or interferometer arrays.

The loop with its plane vertical, is mounted close to the ground in terms of wavelength to obtain addition of incident and reflected signals. The loop element is a welded assembly of aluminum alloy weighing only 10 lbs., and may be mounted on a tripod or bolted to a post with an angle bracket.

Frequency range
2-32 MHz
(MF and LF Models to order)

Polarization
Vertical

Effective height (2-32 MHz)
(Loop-preamplifier into 50 ohms)
2 metres

Directive gain
4.7 dB
(Relative to an isotropic radiator)

Loop diameter
1 metre

Weight of loop assembly
10 lbs

Weight of Tripod assembly
12 lbs

Wind loading
200 mph (no ice)
100 mph (1 inch radial ice)
(Tripod rigidly bolted to ground)

Environmental Temperature range
−40°C to +70°C

Preamplifier MTBF
¼ million hours (at +70°C)

Preamplifier power requirement
100 mA at +12V DC

Directional Characteristics

Azimuth
Figure of eight with nulls on loop axis

Elevation
Omnidirectional in the elevation plane containing the loop.

Model 4E26

Model 4E26 consists of 4 individual loop preamplifier elements arranged in an 'end-fire' configuration using an inter element spacing of 26 ft. (8 metres). This arrangement gives a unidirectional characteristic up to 15 MHz. Above this frequency grating lobes appear limiting the directional gain, however, the main beam characteristics are optimum over the whole 2-32 MHz range.

The elevation characteristics are optimum for both long and short haul communications via the ionosphere, due to the 'opening up' of the elevation pattern at lower frequencies.

4E26 Plan view scaled

Frequency Range
2 to 32 MHz

Polarization
Vertical

Effective Height (2-32 MHz)
(Terminated array)
4 metres

Approximate Directive Gain
(Relative to an isotropic radiator)

2 MHz	5 dB
5 MHz	8 dB
10 MHz	10 dB
15 MHz	11 dB
20 MHz	9 dB
30 MHz	11 dB

Half Power Points

Azimuth

5 MHz	$\pm 43°$
30 MHz	$\pm 27°$

Elevation

5 MHz	80°
30 MHz	30°

Front/Back ratio (4-15 MHz)
Greater than 10 dB

Number of loops in array
4

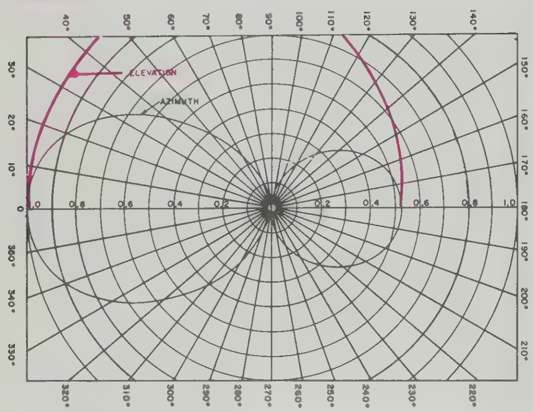
Overall length of array
25 metres

Total weight of array
(Including interconnecting transmission lines but excluding tripods)
100 lbs

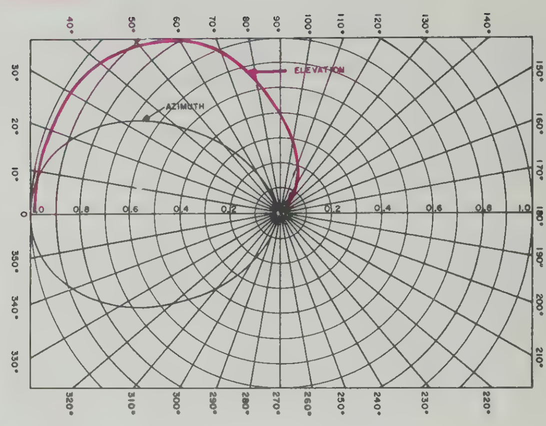
7 tripods
85 lbs

Directional Characteristics
Model 4E26

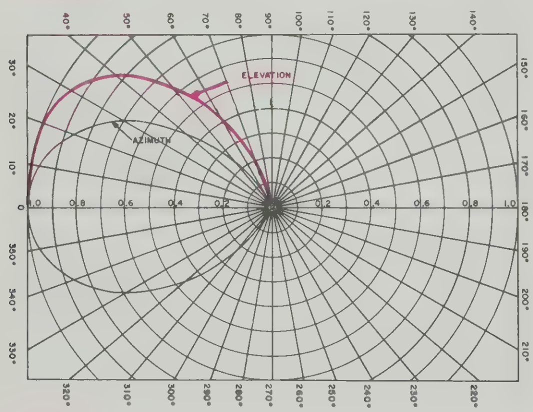
2 MHz



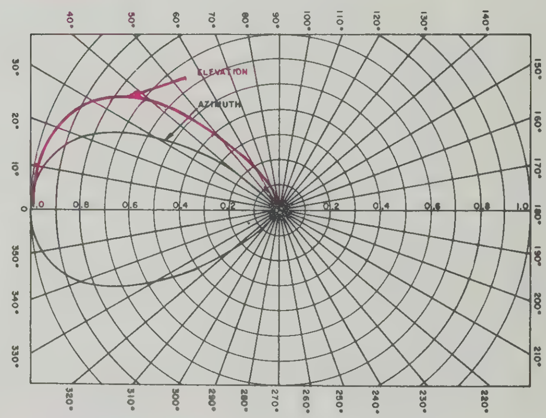
5 MHz



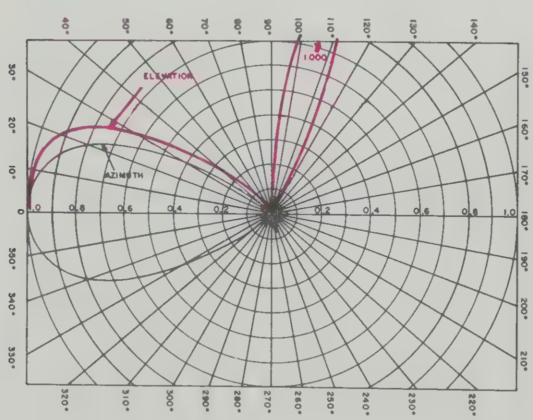
10 MHz



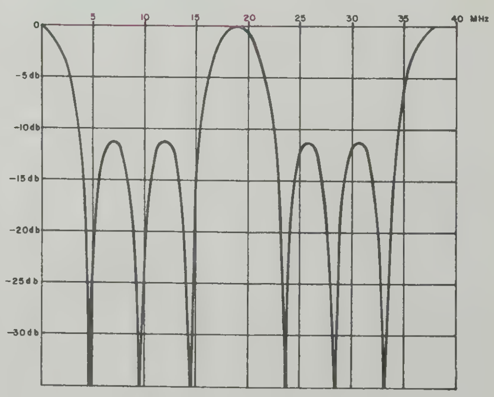
15 MHz



30 MHz



Front/Back ratio

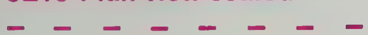


Model 8E13

Model 8E13 consists of 8 individual loop/preamplifier elements arranged in an ‘end-fire’ configuration. The inter element spacing of 13 ft. (4 metres) has been chosen to be less than $\lambda/2$ at 32 MHz, giving a good front/back ratio for the array up to this frequency.

The elevation characteristics are optimum for both long and short haul communications via the ionosphere, due to the ‘opening up’ of the elevation pattern at the lower frequencies.

8E13 Plan view scaled



Frequency Range
2 to 32 MHz

Polarization
Vertical

Effective height (2-32 MHz)
(Terminated array)
8 metres

Approximate Directive Gain
(Relative to an isotropic radiator)

2 MHz	5 dB
5 MHz	8 dB
10 MHz	10 dB
20 MHz	13 dB
30 MHz	14 dB

Half Power Points
Azimuth
5 MHz $\pm$ 43°
30 MHz $\pm$ 27°

Elevation
5 MHz 80°
30 MHz 30°

Front/Back ratio (4 to 32 MHz)
Greater than 13 dB

Number of loops in array
8

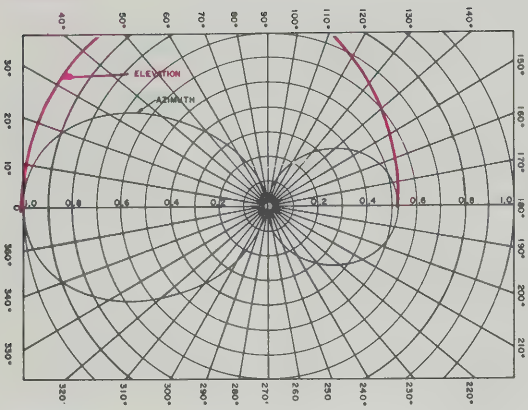
Overall length of array
30 metres

Total weight of array
(Including interconnecting transmission lines but excluding tripods)
150 lbs

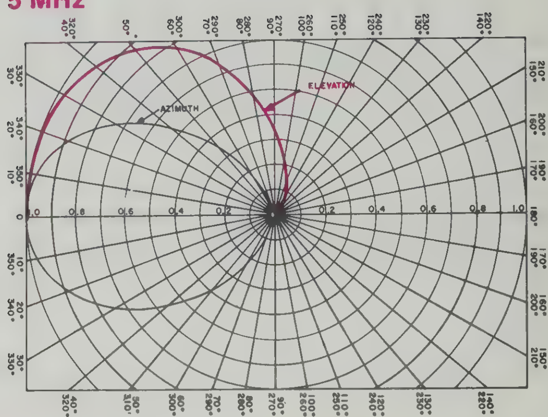
8 Tripods
100 lbs

Directional Characteristics
Model 8E13

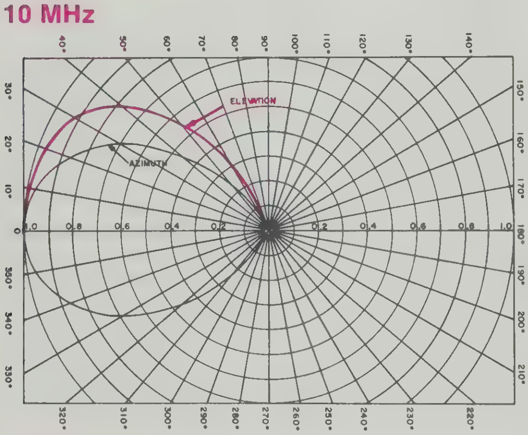
2 MHz



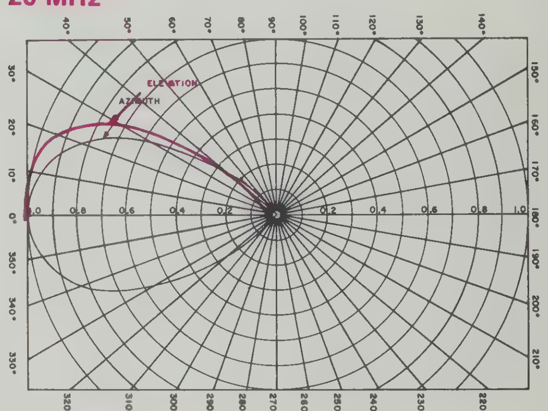
5 MHz



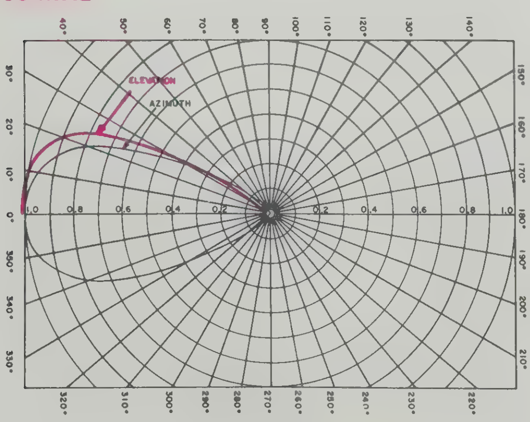
10 MHz



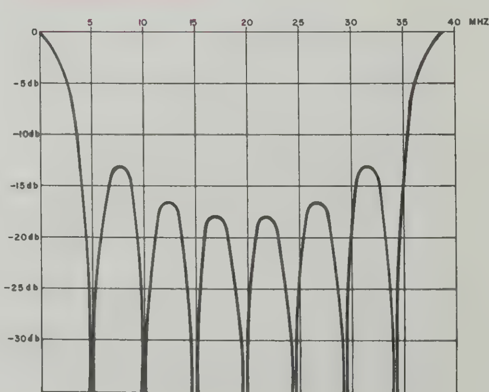
20 MHz



30 MHz

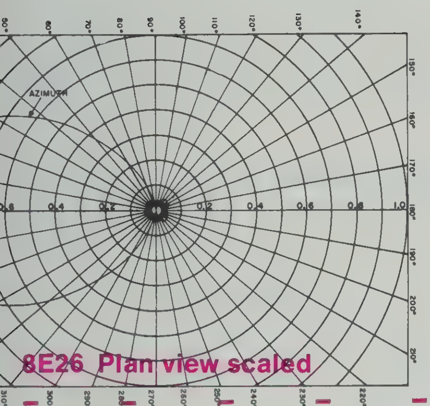


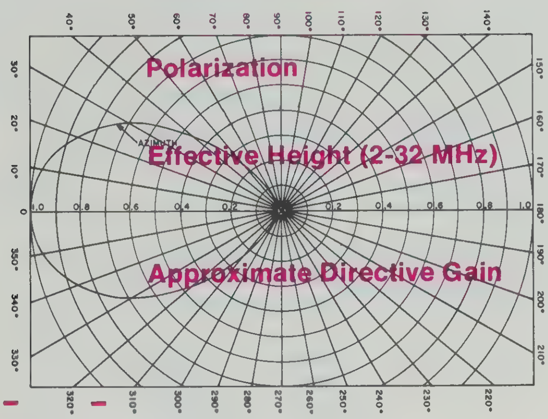
Front/Back ratio



tional Characteristics
18E26

Frequency Range



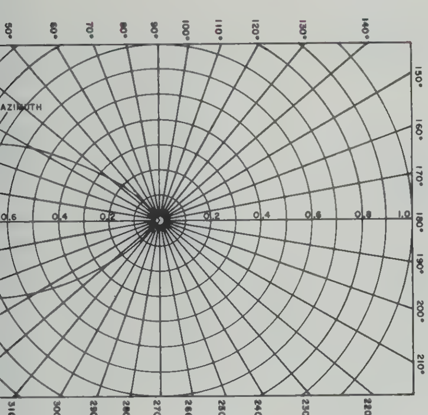


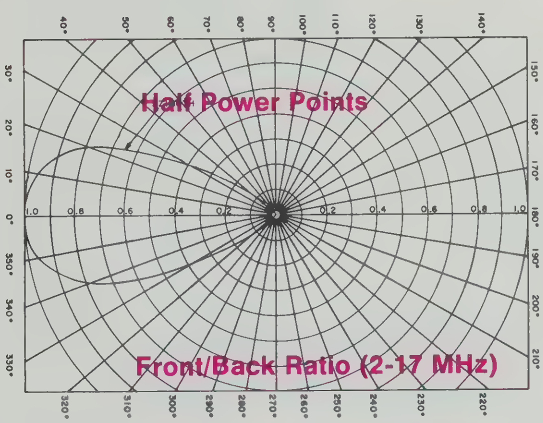
Polarization

Effective Height (2-32 MHz)

Approximate Directive Gain

8E26 Plan view scaled

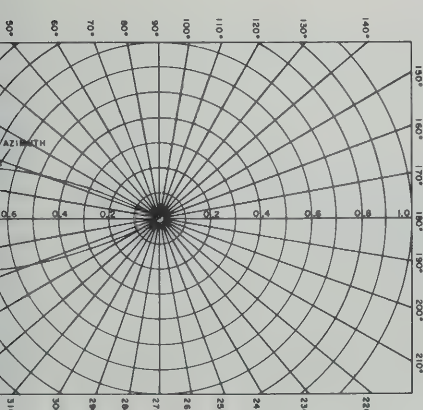




Half Power Points

Front/Back Ratio (2-17 MHz)

Number of loops in array

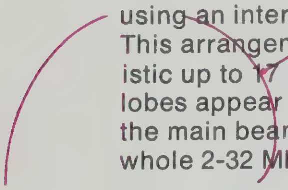


Overall length of array

Total weight of array

Model 8E26

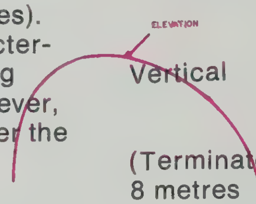
2 MHz



Model 8E26 consists of 8 individual loop preamplifier elements arranged in an 'end-fire' configuration using an inter element spacing of 26 ft. (8 metres). This arrangement gives a unidirectional characteristic up to 17 MHz. Above this frequency grating lobes appear limiting the directional gain, however, the main beam characteristics are optimum over the whole 2-32 MHz range.

The elevation characteristics are optimum for long and medium haul communications via the ionosphere.

5 MHz



2-32 MHz

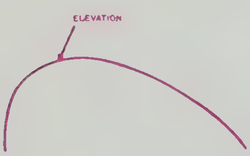
Vertical

(Terminated array)
8 metres

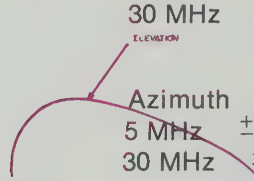
(Relative to an isotropic radiator)

2 MHz	8 dB
5 MHz	10 dB
10 MHz	13 dB
15 MHz	14 dB
20 MHz	11 dB
30 MHz	14 dB

10 MHz



15 MHz

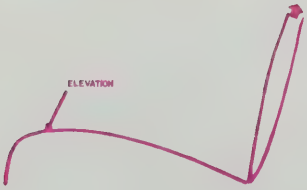


Azimuth
5 MHz $\pm 38°$
30 MHz $\pm 20°$

Elevation
5 MHz 54°
30 MHz 21°

Greater than 13 dB

30 MHz



Front/Back ratio
8

60 metres

(Including interconnecting transmission lines but excluding tripods)
200 lbs

15 tripods
200 lbs

Model 16E13

Model 16E13 consists of 16 individual loop/pre-amplifier elements arranged in an 'end-fire' configuration. The inter element spacing of 13 ft. (4 metres) has been chosen to be less than $\lambda/2$ at 32 MHz, giving a good front/back ratio for the array up to this frequency.

The elevation characteristics are optimum for long and medium haul communications via the ionosphere.

16E13 Plan view scaled

Frequency Range
2 to 32 MHz

Polarization
Vertical

Effective height (2-32 MHz)
(Terminated array)
16 metres

Approximate Directive Gain
(Relative to an isotropic radiator)

2 MHz	8 dB
5 MHz	10 dB
10 MHz	13 dB
20 MHz	15 dB
30 MHz	17 dB

Half Power Points

Azimuth

5 MHz	$\pm 38°$
30 MHz	$\pm 20°$

Elevation

5 MHz	54°
30 MHz	21°

Front/Back ratio (2 to 32 MHz)
Greater than 13 dB

Number of loops in array
16

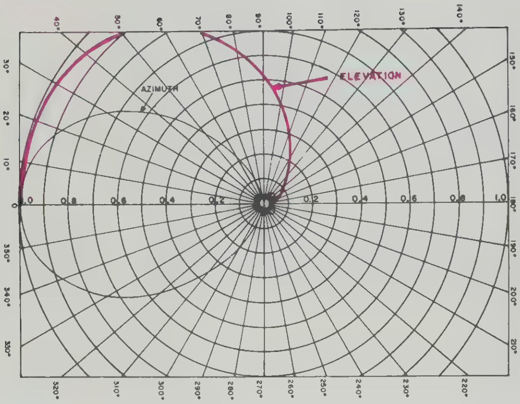
Overall length of array
60 metres

Total weight of array
(Including interconnecting transmission lines but excluding tripods)
300 lbs

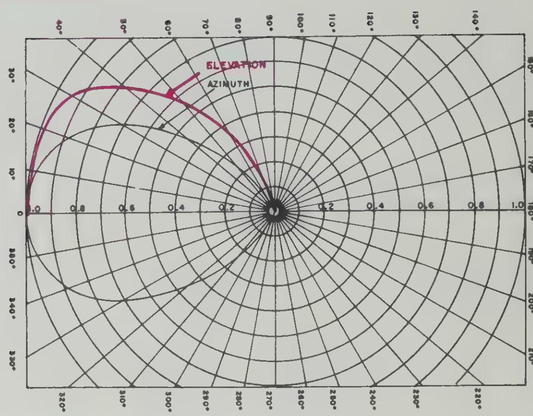
16 Tripods
200 lbs

Directional Characteristics
Model 16E13

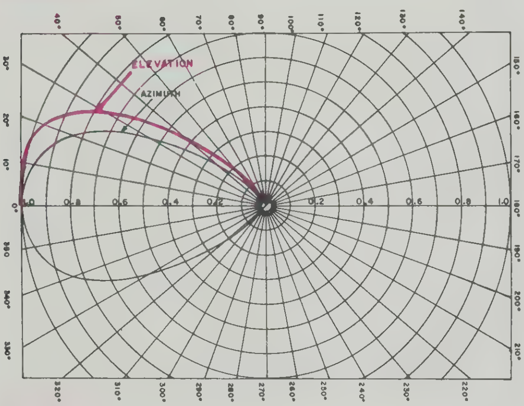
2 MHz



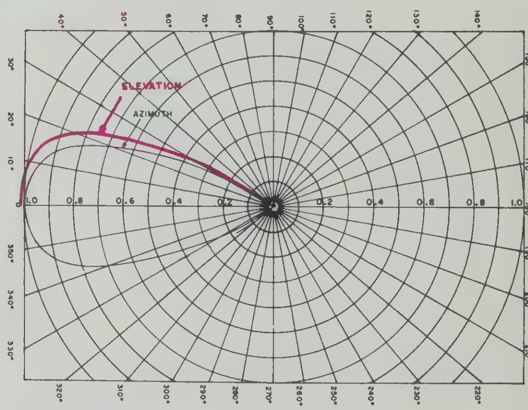
5 MHz



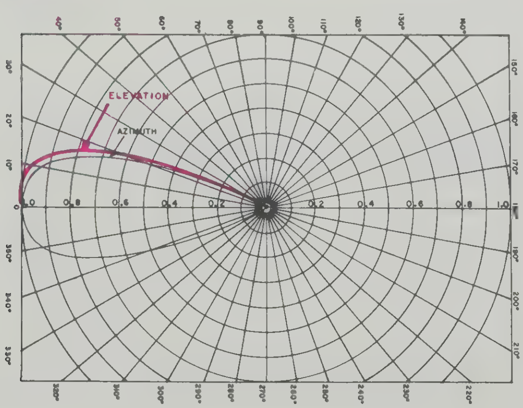
10 MHz



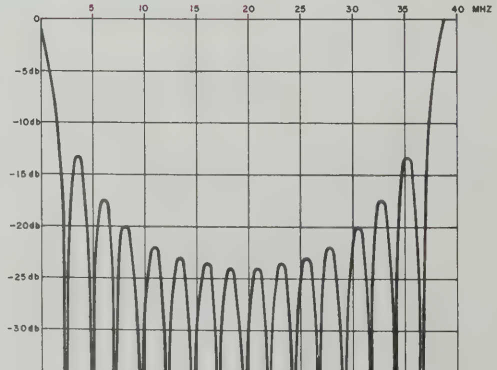
20 MHz



30 MHz



Front/Back ratio

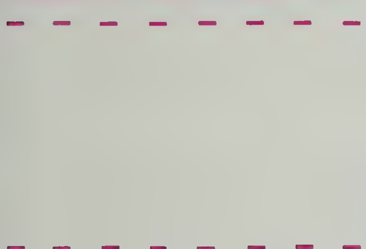


Model 2B/8E13

Model 2B/8E13 consists of two model 8E13 arrays arranged as a broadside pair with a spacing of 2λ at 32 MHz. This arrangement narrows the azimuth beamwidth, but does not change the elevation pattern or the front/back ratio, compared to a single 8E13 array.

The elevation characteristics are optimum for both long and short haul communications via the ionosphere, due to the 'opening up' of the elevation pattern at the lower frequencies.

2B/8E13 Plan view scaled



Frequency Range

2 to 32 MHz

Polarization

Vertical

Effective height (2 to 32 MHz)

(Combined arrays into termination)
12 metres

Approximate Directive Gain

(Relative to an isotropic radiator)

2 MHz	6 dB
5 MHz	10 dB
10 MHz	13 dB
20 MHz	16 dB
30 MHz	17 dB

Half Power Points

Azimuth

5 MHz	±33°
30 MHz	± 8°

Elevation

5 MHz	80°
30 MHz	30°

Front/Back ratio (4 to 32 MHz)

Greater than 13 dB

Number of loops in array

16

Overall length of array

30 metres

Overall width of array

20 metres

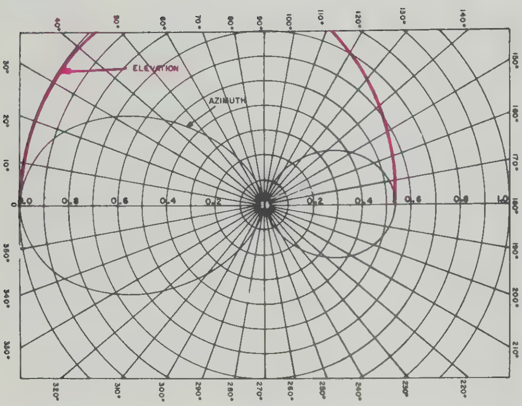
Total weight of array

(Including interconnecting transmission lines but excluding tripods)
300 lbs

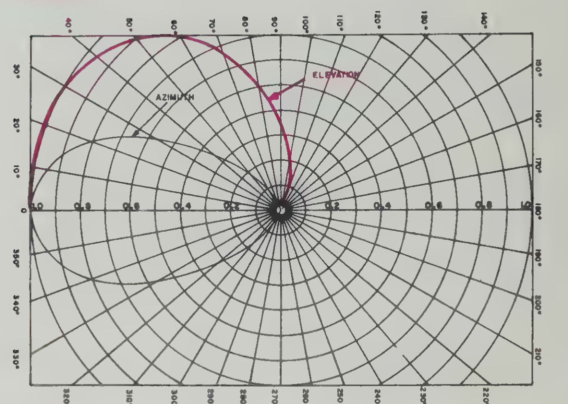
16 Tripods
200 lbs

Directional Characteristics Model 2B/8E13

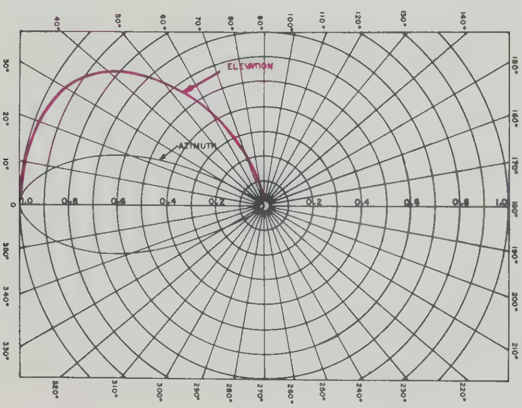
2 MHz



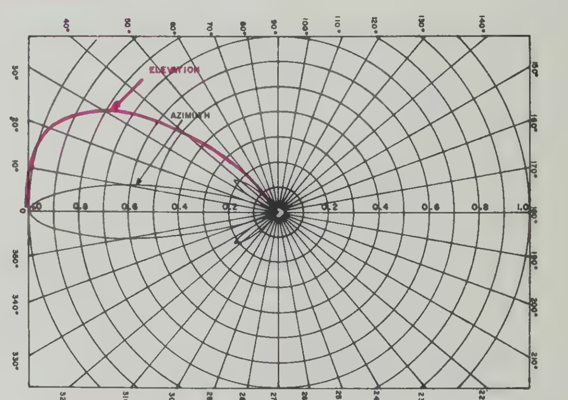
5 MHz



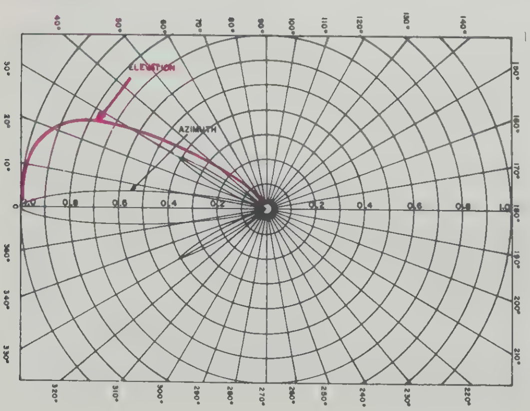
10 MHz



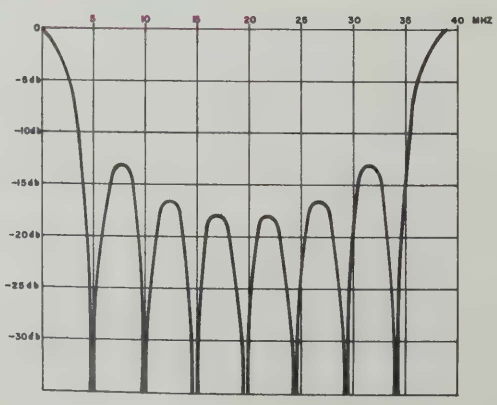
20 MHz



30 MHz



Front/Back ratio

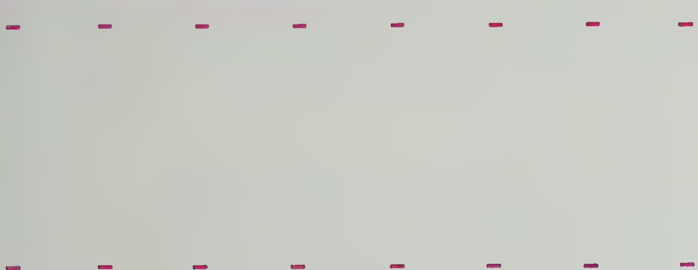


Model 2B/8E26

Model 2B/8E26 consists of two model 8E26 arrays arranged as a broadside pair with a spacing of 2λ at 32 MHz. This arrangement narrows the azimuth beamwidth, but does not change the elevation pattern, or the front/back ratio compared to a single 8E26 array.

The elevation characteristics are optimum for long and medium haul communications via the ionosphere.

2B/8E26 Plan view scaled



Frequency range
2-32 MHz

Polarization
Vertical

Effective height (2-32 MHz)
12 metres
(Combined arrays into termination)

Approximate Directive Gain
(Relative to an isotropic radiator)

2 MHz	8 dB
5 MHz	11 dB
10 MHz	15 dB
15 MHz	16 dB
20 MHz	14 dB
30 MHz	17 dB

Half Power Points

Azimuth
5 MHz ±33°
30 MHz ± 8°

Elevation
5 MHz 54°
30 MHz 21°

Front/Back ratio (2-17 MHz)
Greater than 13 dB

Number of loops in array
16

Overall length of array
60 metres

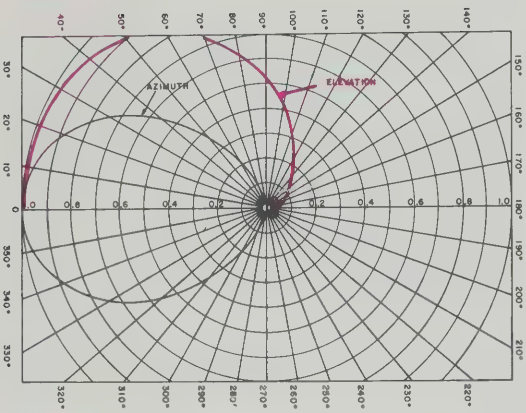
Overall width of array
20 metres

Total weight of array
(Including interconnecting transmission lines but excluding tripods)
400 lbs

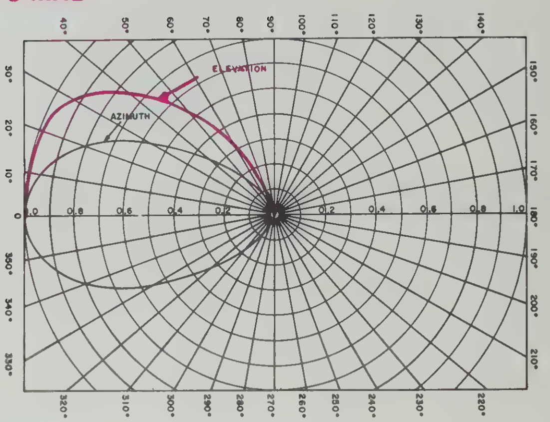
30 tripods
360 lbs

Directional Characteristics
Model 2B/8E26

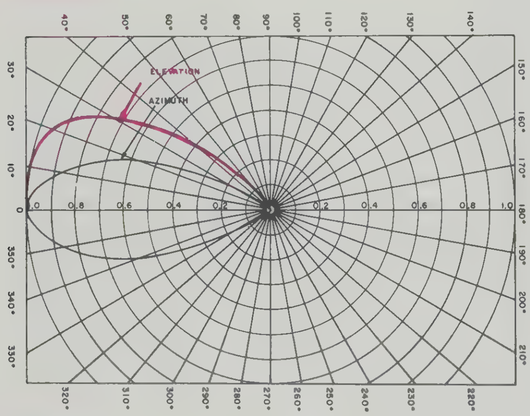
2 MHz



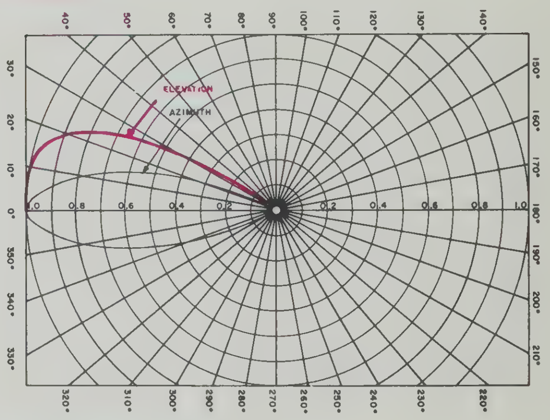
5 MHz



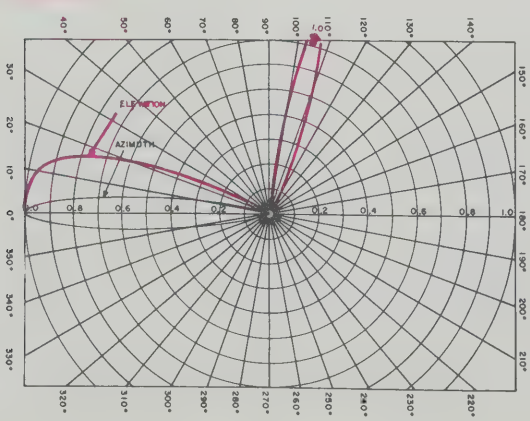
10 MHz



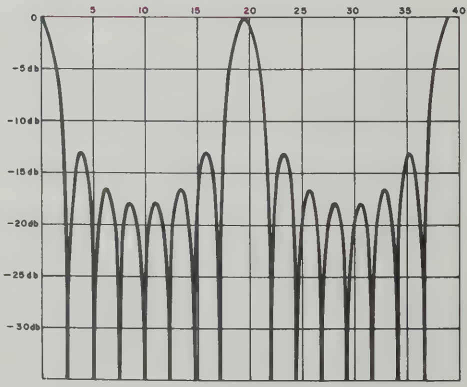
15 MHz



30 MHz



Front/Back ratio



Model 2B/16E13

Model 2B/16E13 consists of two model 16E13 arrays arranged as a broadside pair with a spacing of 2 λ at 32 MHz. This arrangement narrows the azimuth beamwidth, but does not change the elevation pattern or the front/back ratio, compared to a single 16E13 array.

The elevation characteristics are optimum for long and medium haul communications via the ionosphere.

2B/16E13 Plan view scaled

Frequency Range

2 to 32 MHz

Polarization

Vertical

Effective height (2 to 32 MHz)

12 metres
(Combined arrays into termination)

Approximate Directive Gain

(Relative to an isotropic radiator)

2 MHz	8 dB
5 MHz	11 dB
10 MHz	15 dB
20 MHz	18 dB
30 MHz	20 dB

Half Power Points

Azimuth

5 MHz	±33°
30 MHz	± 8°

Elevation

5 MHz	54°
30 MHz	21°

Front/Back ratio (2 to 32 MHz)

Greater than 13 dB

Number of loops in array

32

Overall length of array

60 metres

Overall width of array

20 metres

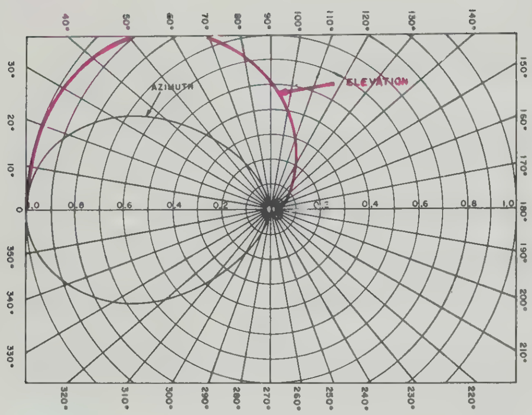
Total weight of array

(Including interconnecting transmission lines but excluding tripods)
600 lbs

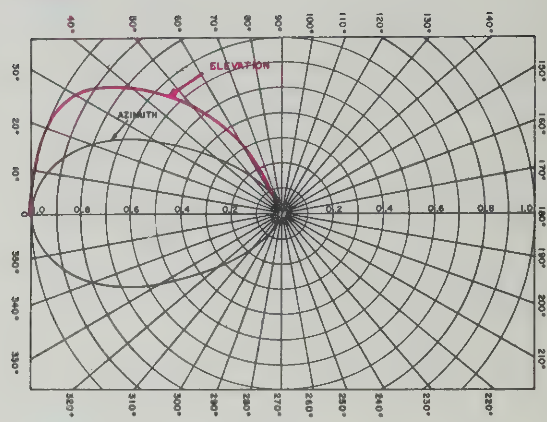
32 Tripods
400 lbs

Directional Characteristics
Model 2B/16E13

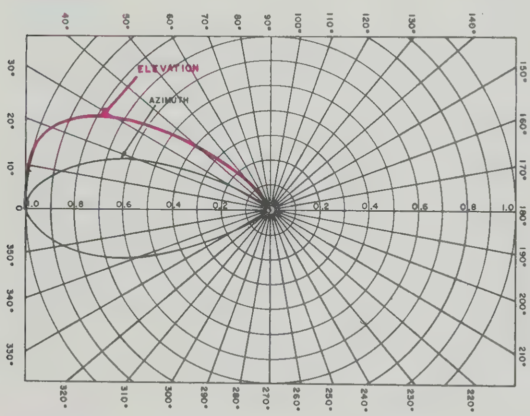
2 MHz



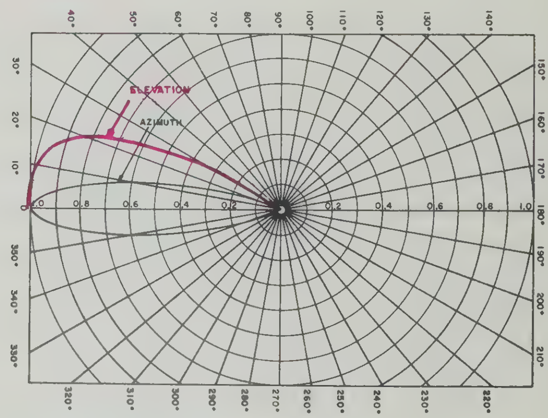
5 MHz



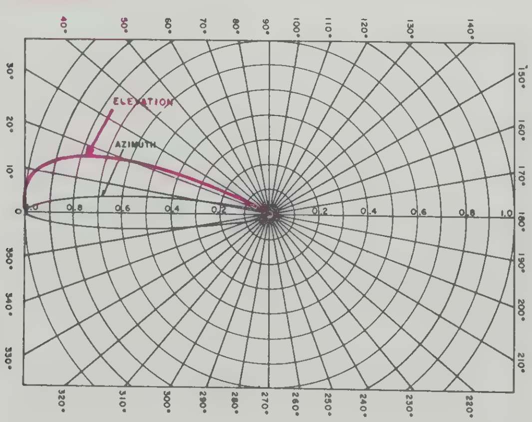
10 MHz



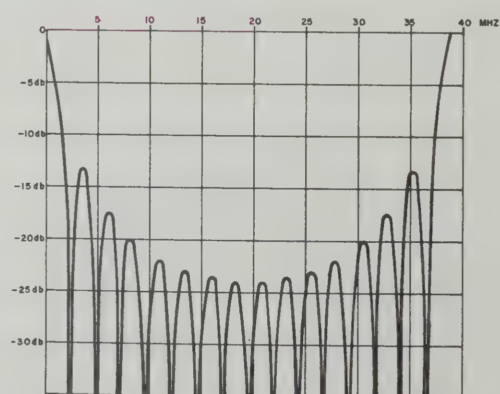
20 MHz



30 MHz



Front/Back ratio



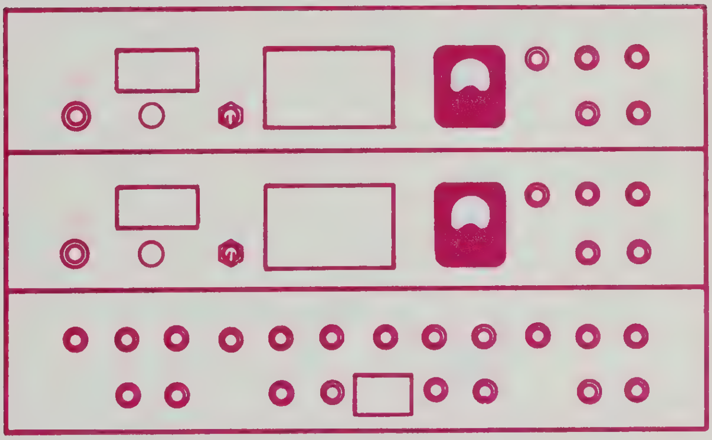
Model 3R/4E26

Model 3R/4E26 provides complete 360° coverage in azimuth, by employing three 4E26 Aperiodic Loop Antenna Arrays in a radial configuration or Rosette. This arrangement is possible because of the low mutual coupling between individual elements which enables the arrays to be placed close to one another. Outputs are taken simultaneously from each end of each array to provide full omnidirectional coverage.

The 3R/4E26 comprises three Model 4E26 Aperiodic Loop Antenna Arrays arranged at 60° to one another. The performance of each array is identical to the specification for Model 4E26. Receiver outputs are provided in six 60° sectors with four outlets available for each sector. (Additional outlets can be provided to order).

3R/4E26 Plan view scaled

Power Supply - Multiple Multicoupler

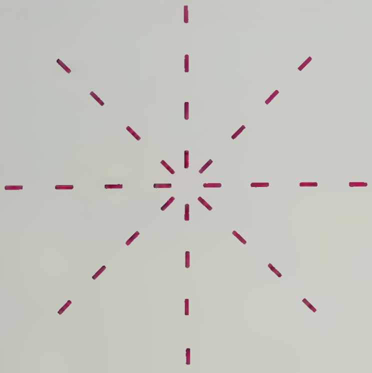


Model 4R/8E13

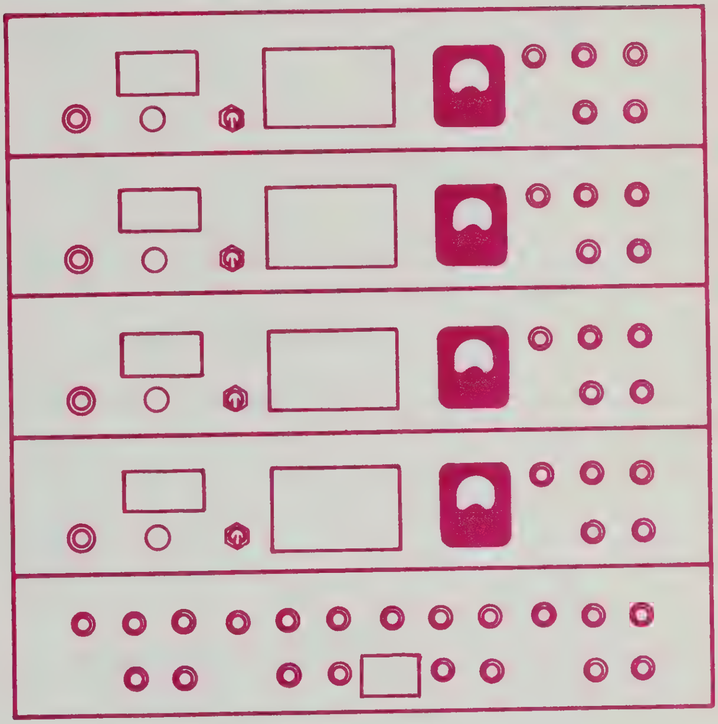
Model 4R/8E13 provides complete 360° coverage in azimuth, by employing four 8E13 Aperiodic Loop Antenna Arrays in a radial configuration or Rosette. This arrangement is possible because of the low mutual coupling between individual elements which enables the arrays to be placed close to one another. Outputs are taken simultaneously from each end of each array to provide full omnidirectional coverage.

The 4R/8E13 comprises four Model 8E13 Aperiodic Loop Antenna Arrays arranged at 45° to one another. The performance of each array is identical to the specification for Model 8E13. Receiver outputs are provided in eight 45° sectors with four outlets available for each sector. (Additional outlets can be provided to order).

4R/8E13 Plan view scaled



Power Supply - Multiple Multicoupler

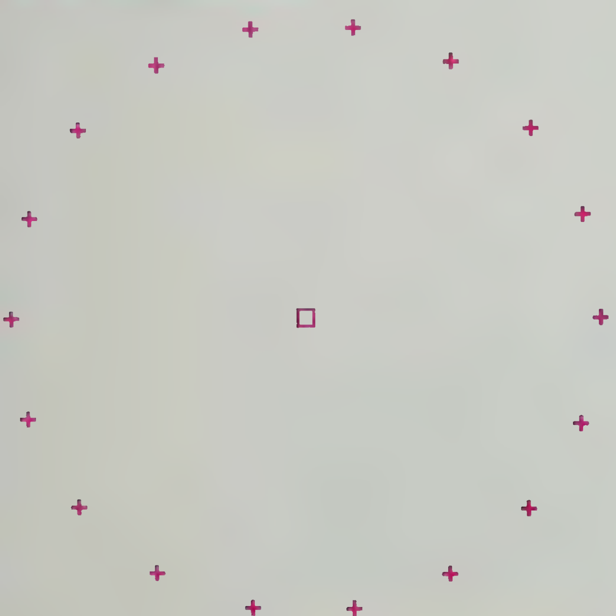


Model 18C50

Model 18C50 consists of Loop Antenna Elements arranged around the circumference of a 50 metre diameter circle. All the loop outputs are fed to the centre of the circle where phasing networks produce a number of independent unidirectional sector beams centered on different azimuth directions. The directional gain characteristics of each sector beam are optimum for long and medium haul communications via the ionosphere. The phasing networks are so arranged that at 30 MHz, where the beamwidths are a minimum, adjacent beam patterns overlap approximately at their −3 dB points, thus ensuring complete azimuth coverage in a number of independent high directional gain sectors.

The number of sector beams, and hence phasing networks, can be specified to ensure coverage of only the required azimuth directions. These beams are centered on bearings 10 degrees apart, so a maximum of 36 are required to give complete azimuth coverage. Wide azimuth beams can be formed, by combination of individual sector beams, for search and acquisition of signals. Normally four 50 ohm receiver outlets are provided for each sector, but a greater number can be supplied to special order.

18C50 Plan view scaled



Number of Sector Outputs
Up to 36 (on azimuth angles 10° apart)

Frequency Range
1.5 - 30 MHz

Polarization
Vertical

Effective Height
(Each terminated sector output)
10 metres

Approximate Directive Gain

(Each sector output)

1.5 MHz	7 dB
3 MHz	10 dB
6 MHz	12 dB
12 MHz	15 dB
18 MHz	16 dB
30 MHz	17 dB

Half Power Points
(Each sector output)

Azimuth

3 MHz	±32°
12 MHz	±10°
30 MHz	±4.5°

Elevation

3 MHz	78°
12 MHz	35°
30 MHz	22°

Front/Back Ratio
(1.5 to 5 MHz) Greater than 6 dB
(5 to 30 MHz) Greater than 10 dB

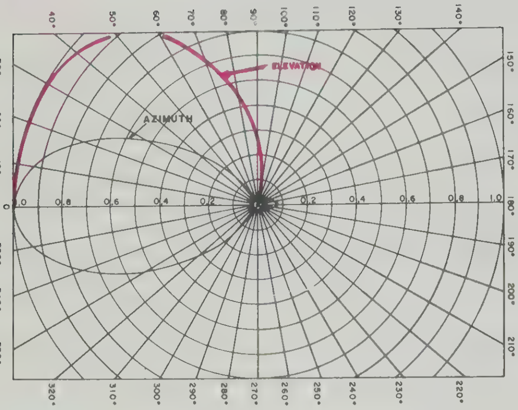
Number of Crossed Loops in Array
18

Overall Diameter of Array
50 metres

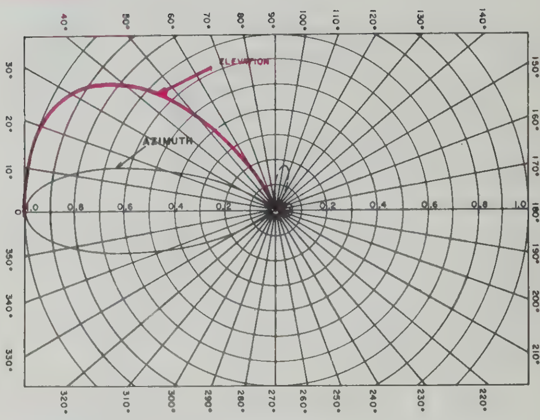
Total Weight of Array
Approximately 1,000 lbs.

Directional Characteristics
Model 18C50

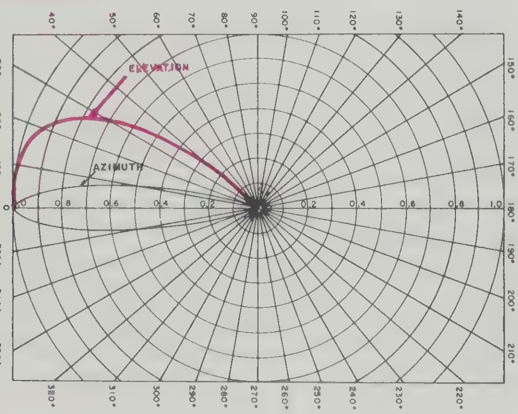
3 MHz



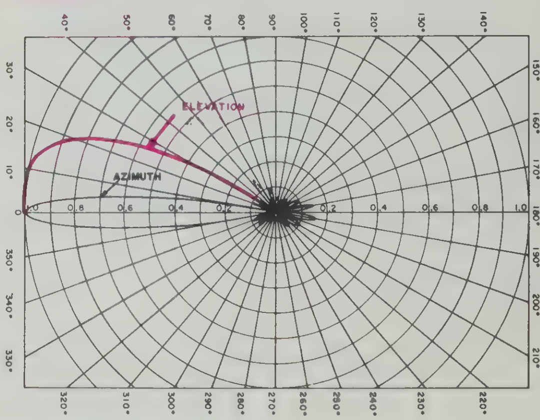
6 MHz



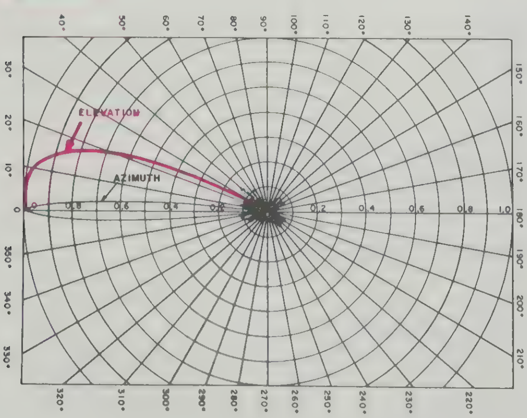
12 MHz



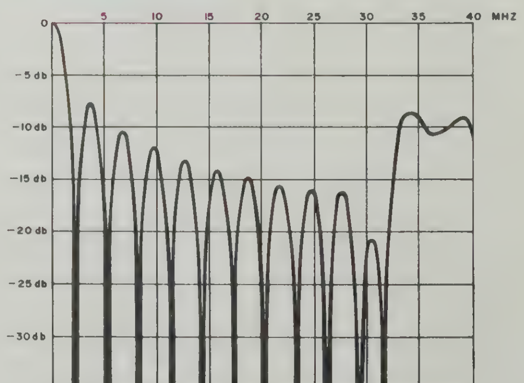
18 MHz



30 MHz



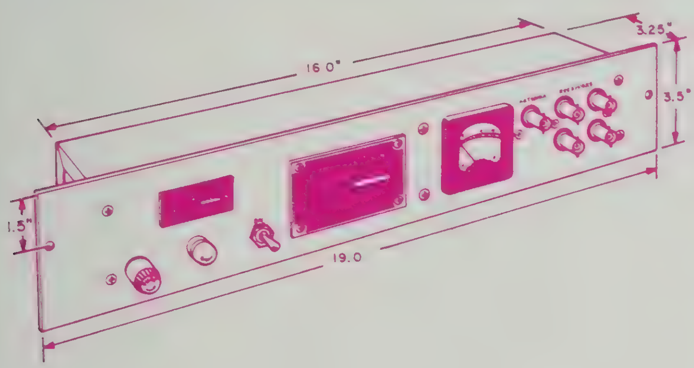
Front/Back ratio



Power Supply/Multicoupler

This unit provides the DC power to the preamplifiers, via the coaxial cable connecting the array to the receiver building. It includes a multicoupler enabling a maximum of four receivers to be operated independently and simultaneously from a single array.

The DC power output circuit is current limited to prevent damage due to short circuit conditions, and includes an ammeter showing the total current drawn by the array preamplifiers. This provides an indication of a fault condition in a preamplifier.



Power Supply Input voltage
115V ±10%
50/60 Hz
(230V model available to order)

RF Input and Output impedance
50 ohms

RF Connectors
BNC

Receiver outputs
4
(Additional outputs available to order)

Isolation between receiver outputs
Greater than 20 dB

DC Output
+12V
(Current limited to 2A nominal)

Array current requirements
200 mA per 4 output multicoupler
100 mA per loop preamplifier

(Thus this unit can feed up to 16 loop elements).

Weight
10 lbs

Multiple Multicoupler Unit

This unit contains four independent four output multicoupler units. It is used to provide additional multicoupled outputs when both ends of linear arrays are used simultaneously, as in the Rosette systems. It may also be used in conjunction with a standard array power supply multicoupler unit to increase the available receiver outputs from 4 to 16.

Power for the multicoupler units is obtained from a standard array power supply.

The RF connectors can be supplied for front or rear panel mounting, to order.

Receiver outlets
4 x 4

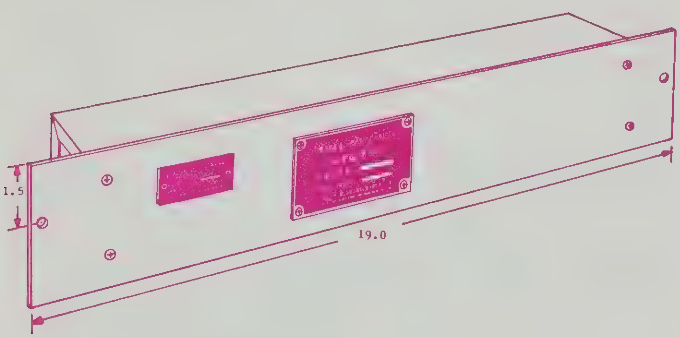
RF Connectors
BNC

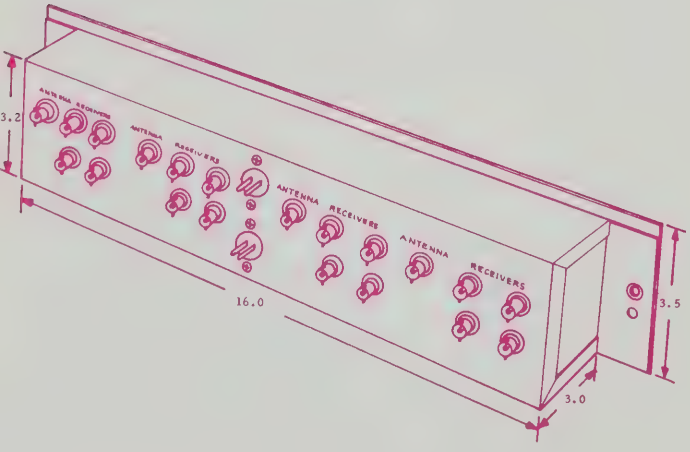
RF Input and Output impedance
50 ohms

Isolation between outputs
Greater than 20 dB

DC power requirement
+12V at 800 mA

Weight
5 lbs

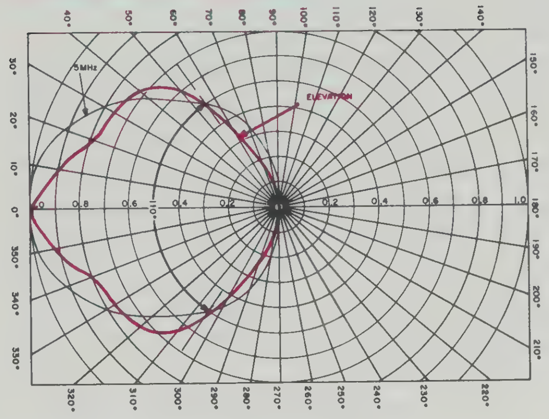




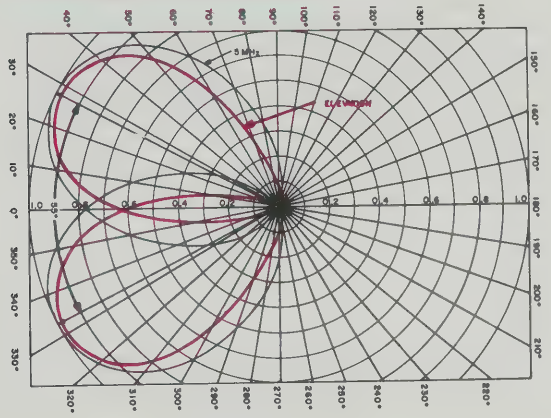
Wide Azimuth Arrays

Linear arrays, which are arranged to cross at their centre points, can be combined to form one beam which is widened only in azimuth. Correct choice of the angle between the arrays can result in a constant combined 3 dB azimuth beamwidth over the working frequency range. The individual array beams can be made available as well, if maximum directivity is required. The illustration shows two Model 8E13 arrays, inclined at 55 ° to one another, giving a combined azimuth beamwidth of 110 ° over the working frequency range.

Combined Array Output



Individual Array Outputs



Aperiodic Arrays for MF and LF

Electrically small active antennas are equally suitable for reception of signals in the medium and low frequency bands, due to the high background atmospheric noise levels present. A 1 metre diameter loop element, with preamplifier modifications for the particular frequency range, will yield antenna system noise factors approaching 3 dB in these bands.

The loop elements can be connected to form 'endfire' arrays using normal coaxial cable instead of special air spaced lines between the elements. These arrays can yield unidirectional beam patterns over a wide frequency range. The performance of a four element endfire array is quoted below in terms of f min and f max, the lower and upper operating frequencies respectively.

	f min	**f max**
Azimuth beamwidth between 3 dB points	90°	60°
Elevation beamwidth between 3 dB points	90°	35°
Approximate directive gain relative to an isotropic radiator	7 dB	10 dB
Front/Back ratio	Greater than 10 dB	

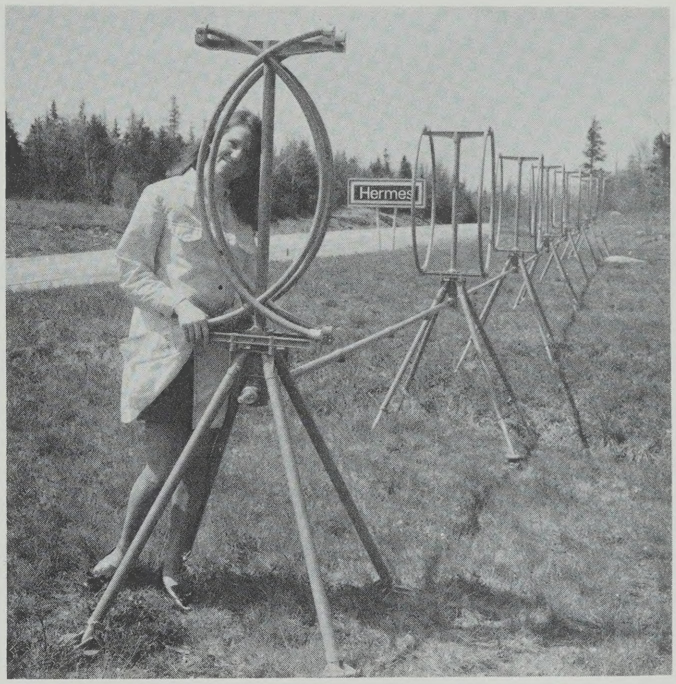
Model	**Frequency Range**	**Overall Array Length**
4E2000	40 - 100 KHz	1800 metres
4E500	160 - 400 KHz	450 metres
4E50	1.6 - 3.8 MHz	45 metres

UltraCompact Loop Array

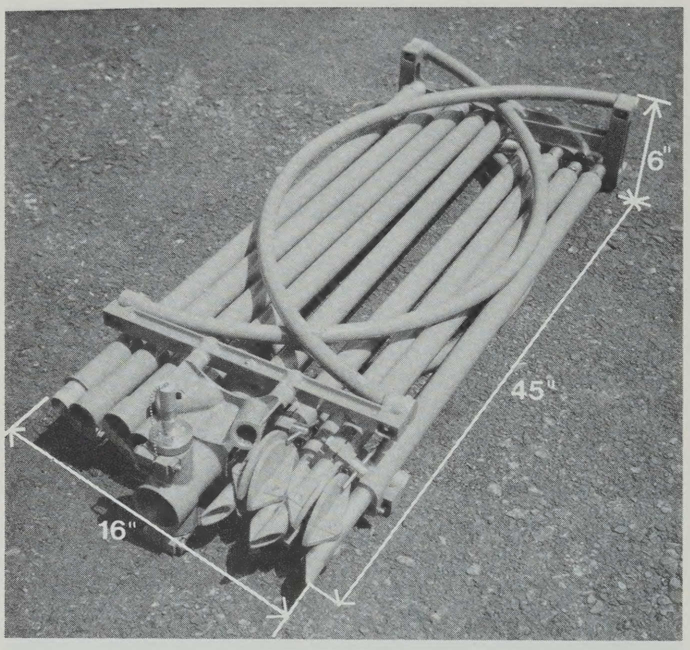
This model is designed for quick erection at a site, and to pack into the minimum transportation volume. The electrical performance is identical to the standard loop antenna, and it is equally suitable for permanent or temporary installations.

The illustrations show the way the half loops fold over one another, and the legs and transmission line sections fit within each collapsed loop element.

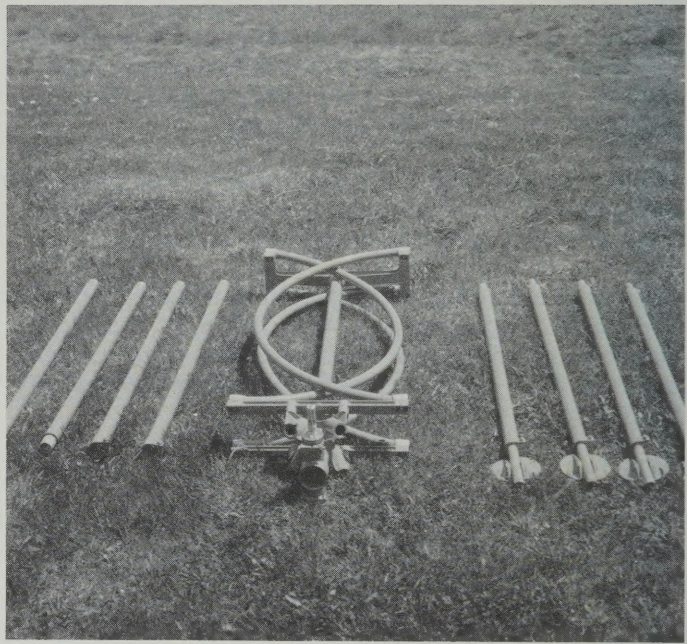
Each element complete with 13 foot transmission line and support legs occupies 45" x 16" x 6", thus four element assemblies form a convenient transportation package of 4' x 2-½' x 1-½' weighing approximately 150 lbs.



Model 8E13C, showing one loop folded



Loop, support legs and transmission line in collapsed form



Loop support legs and transmission line parts